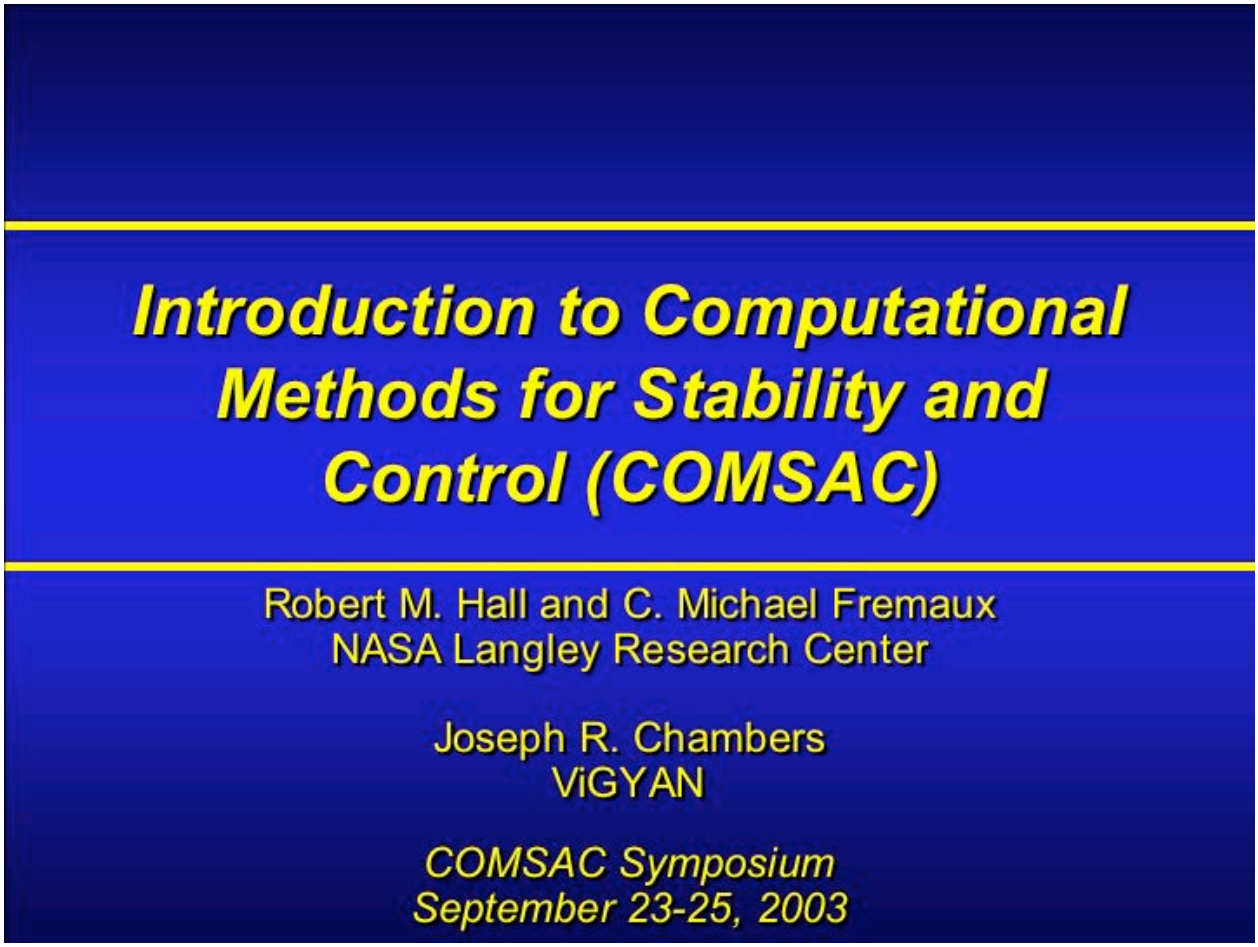
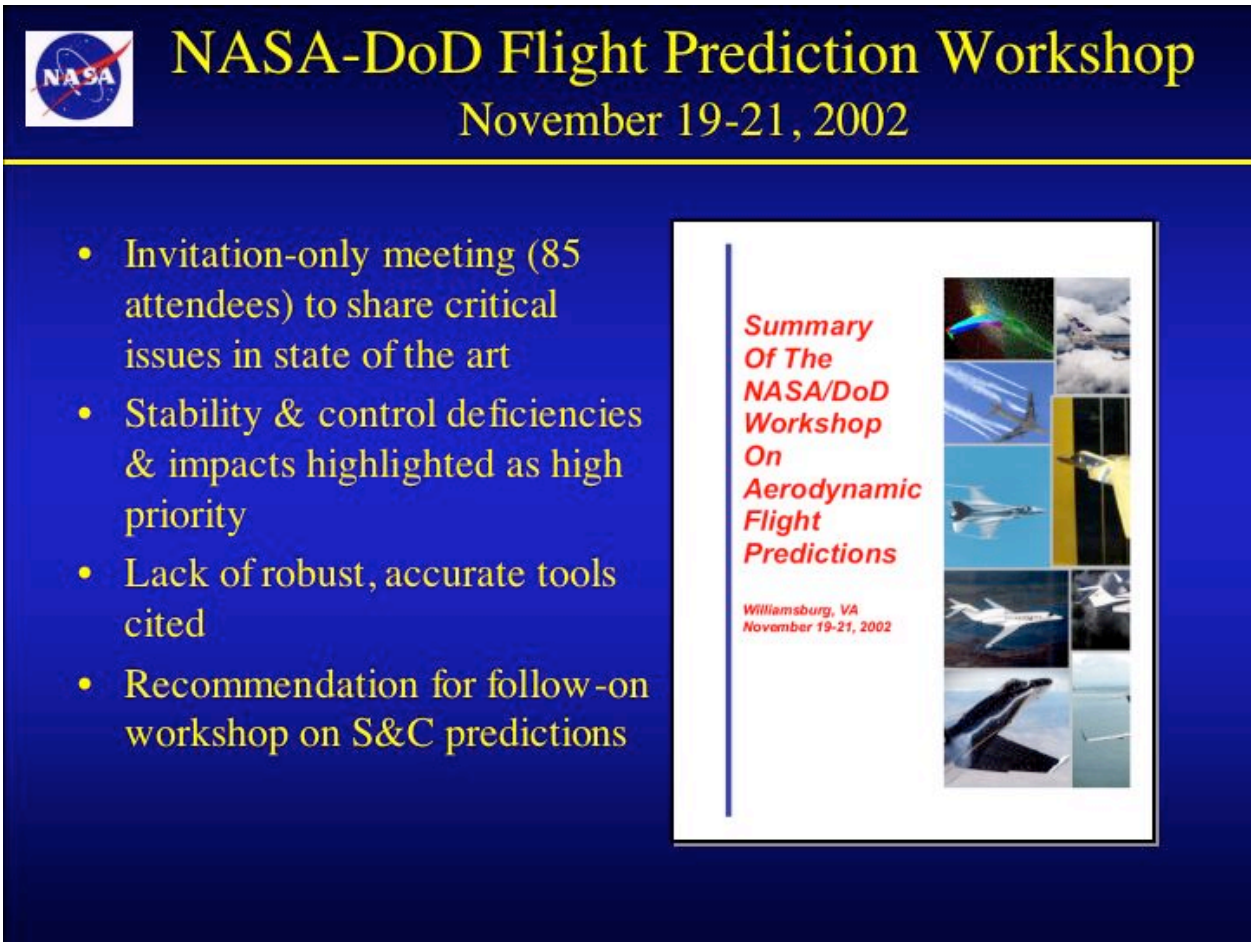
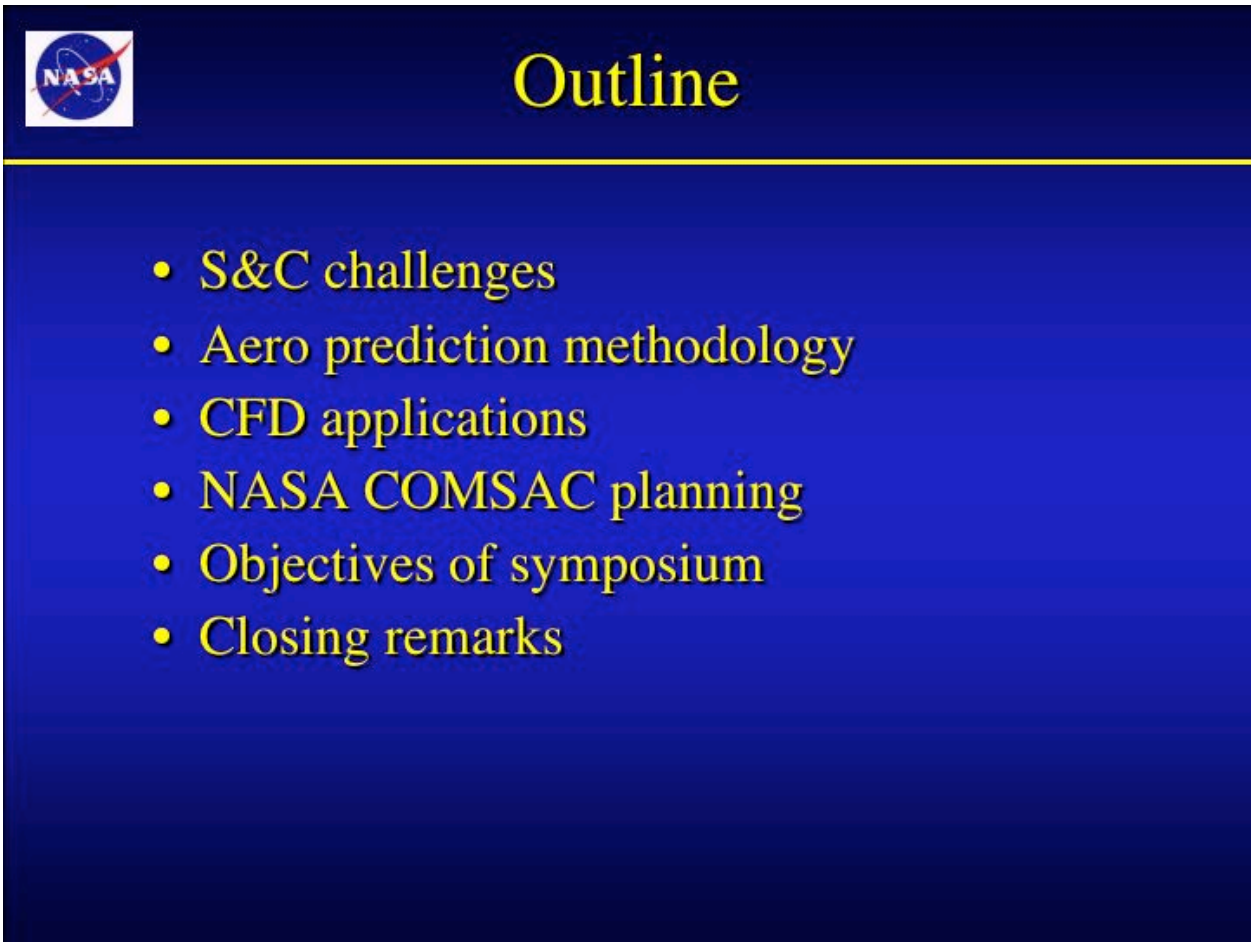
This Symposium is intended to bring together the often distinct cultures of the Stability and Control (S&C) community and the Computational Fluid Dynamics (CFD) community. The COMSAC program is itself a new effort by NASA Langley to accelerate the application of high-end CFD methodologies to the demanding job of predicting stability and control characteristics of aircraft. This talk is intended to set the stage for needing a program like COMSAC. It is not intended to give details of the program itself.

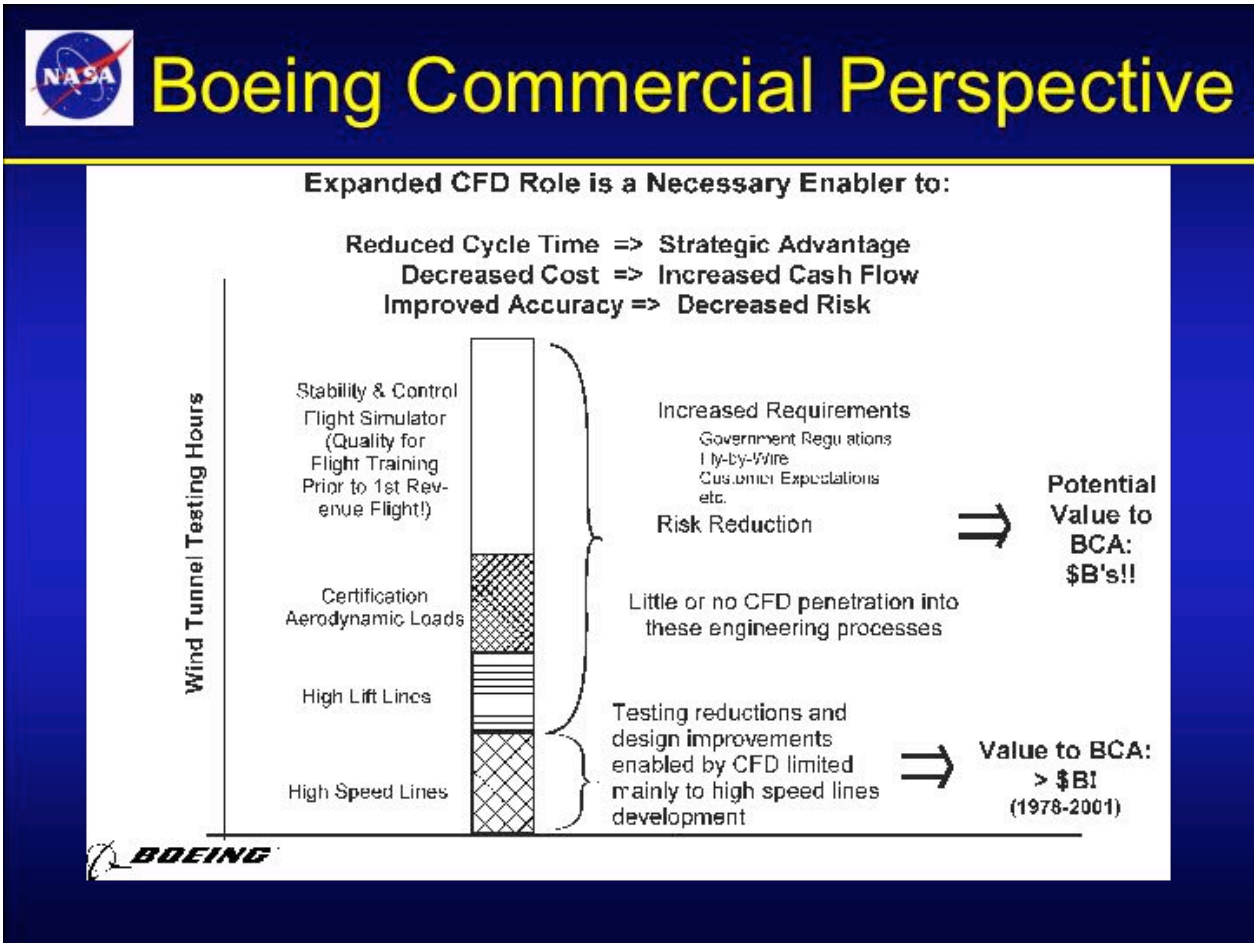


While there are many reasons to have this Symposium, a direct motivation for this event was the Flight Prediction Workshop.




Outline
• S&C challenges
• Aero prediction methodology
• CFD applications
• NASA COMSAC planning
• Objectives of symposium
• Closing remarks

This chart, by Doug Ball of Boeing Commercial, highlights the large amount of wind tunnel resources that are dedicated to determining stability and control characteristics, certification requirements, and low-speed lines. CFD has not generally penetrated these needs areas.



Impacts occur across of vehicle classes--767,F/A-18E, C130J, T-45,X-43 Stack, 777, Lear 23, AV-8B, and 737NG.

- 767--Stall for 767-400 model with raked tips more rapid than expected--vortilon pattern had to be developed
- F/A-18E--wing drop at transonic speeds. Impact: program almost canceled.
- C-130J--wing drop due to propeller induced effects. Impact: delayed deliveries, increased development costs
- T-45--low speed approach wing drop. Impact: redesigned wing
- X-43 Stack--inaccuracies of S&C aero data base. Impact: lost research vehicle

- 777--missed horizontal tail effectiveness. Impact: larger than needed horizontal
- Lear 23--Laminar separation bubble breakdown leading to wing drop on approach. Impact: safety of flight, development costs
- AV8B--wing drop and wing rock. Impact on operational envelopes (considered minimal)
- 737--737NG (400 to 800) sensitivity to wing rigging with unacceptable number of aircraft not passing acceptance flights. Impact: production expenses and development costs

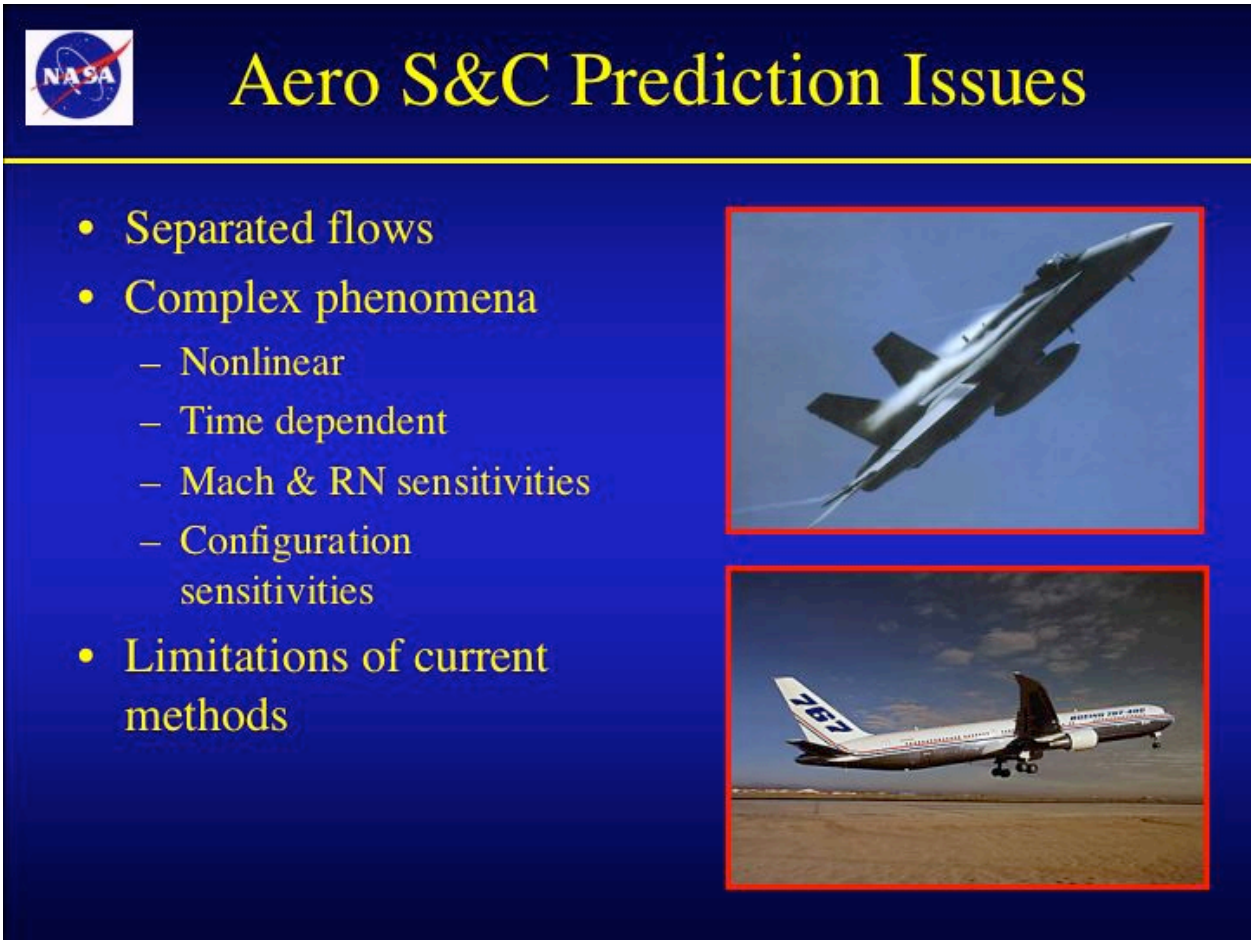
Results of Unpredicted S&C

- Unexpected development activities
  - Wind-tunnel tests
  - Flight tests
  - Flight controls
- Non-optimum modifications or operational limitations
- Delayed delivery schedules
- Increased development costs

S&C Challenges

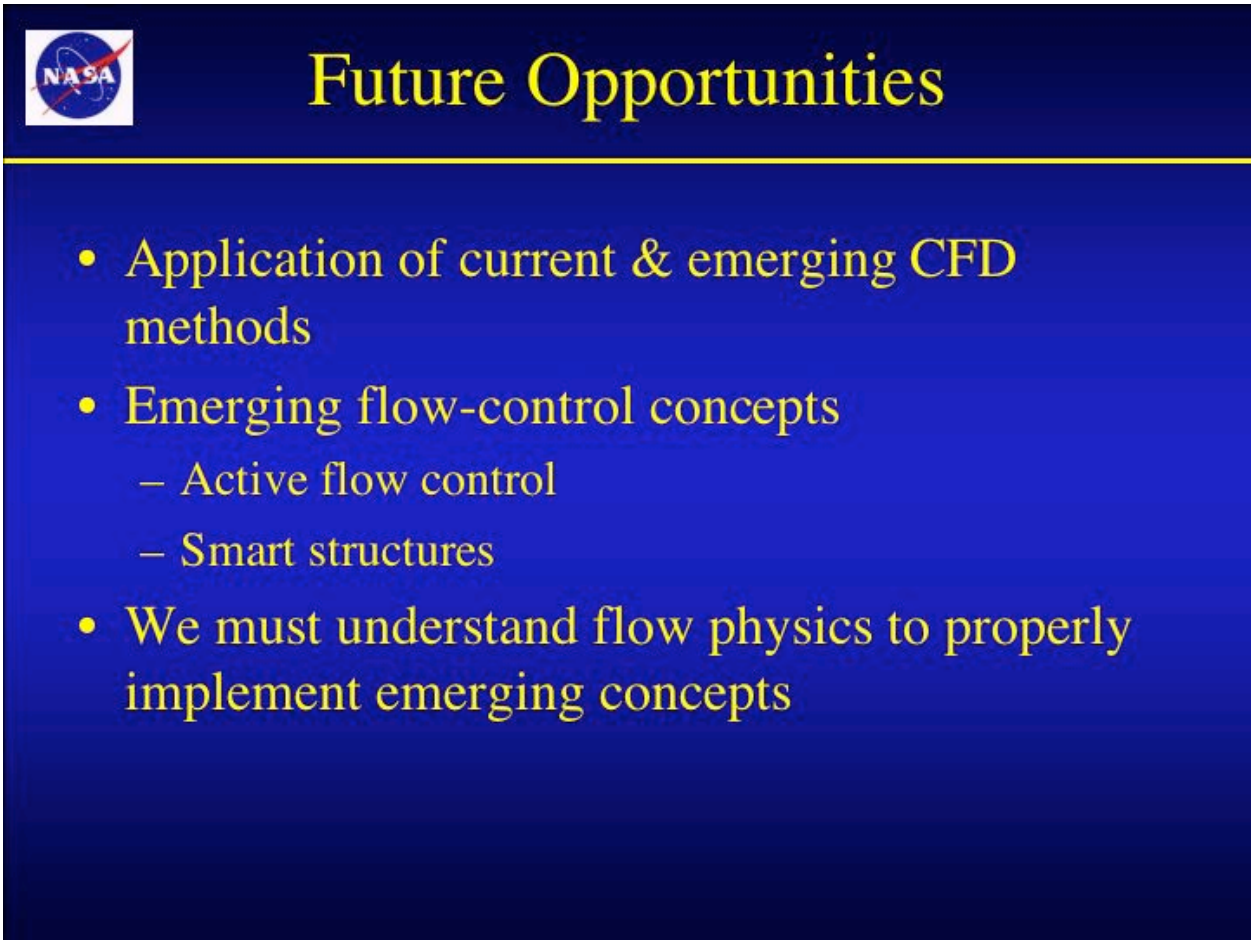
- S&C is a key enabling technology for all vehicle classes
- Major element in aircraft development programs
  - Over 65% of non-propulsion wind-tunnel test hours
  - Extensive piloted simulator studies
  - Major impact on design of flight controls
  - Requires unique test aircraft & flight tests
- Despite best practices, virtually every new aircraft program encounters unexpected aerodynamic S&C problems
  - Cut-and-try in flight solutions

Existing tools and methods for predicting characteristics when flow is primarily attached are adequate. However, when separation becomes significant, analytical tools are inadequate and CFD methods have not been calibrated, in general.

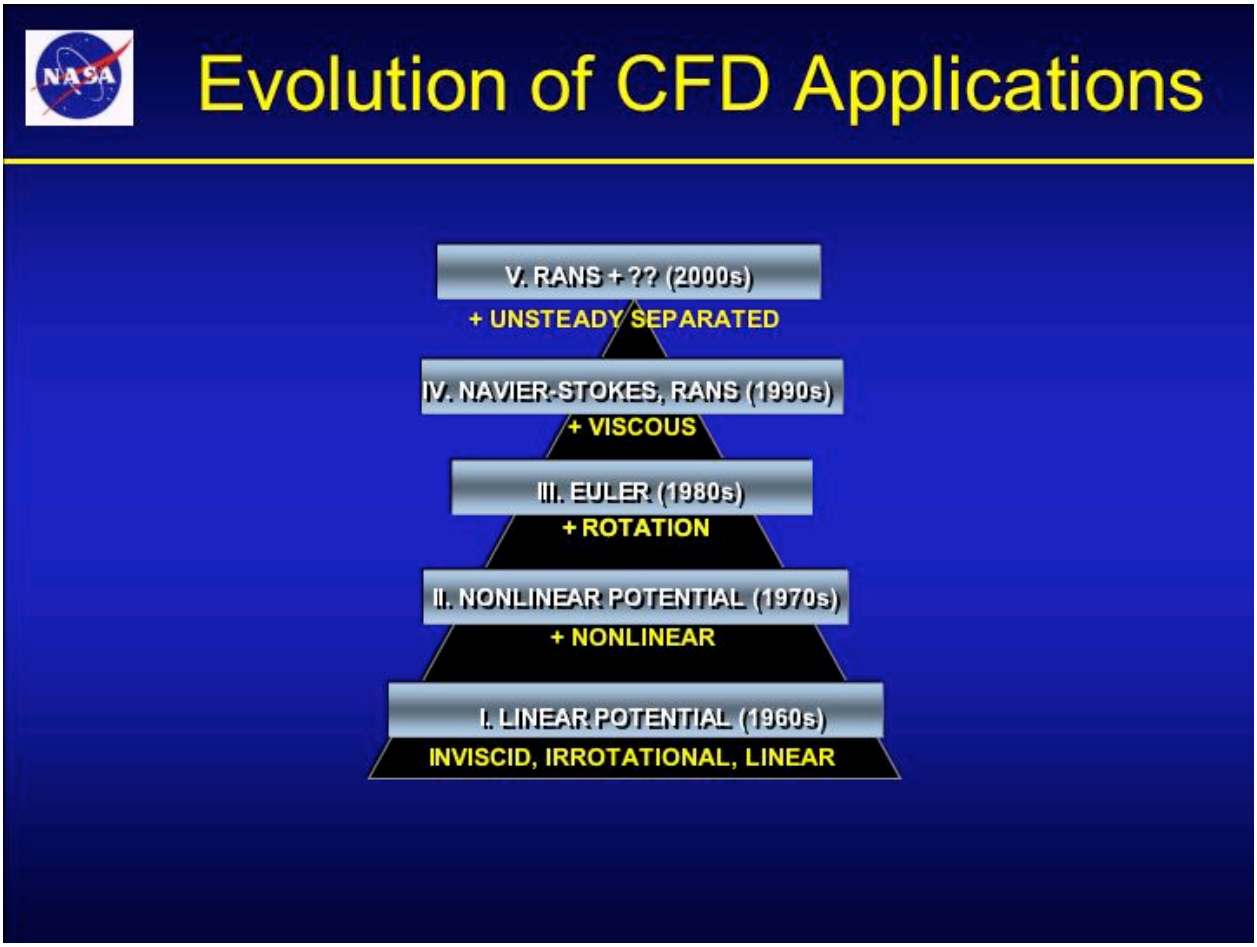


While wind tunnel availability is decreasing, needs for aero data bases are increasing. Computational tools will be needed to complement wind tunnel data to an increasing extent in the future.

As will be reported in this Symposium, current and emerging CFD methods offer the exciting promise of new approaches to address the S&C needs. This will be even more important as emerging flow-control concepts are brought on line.

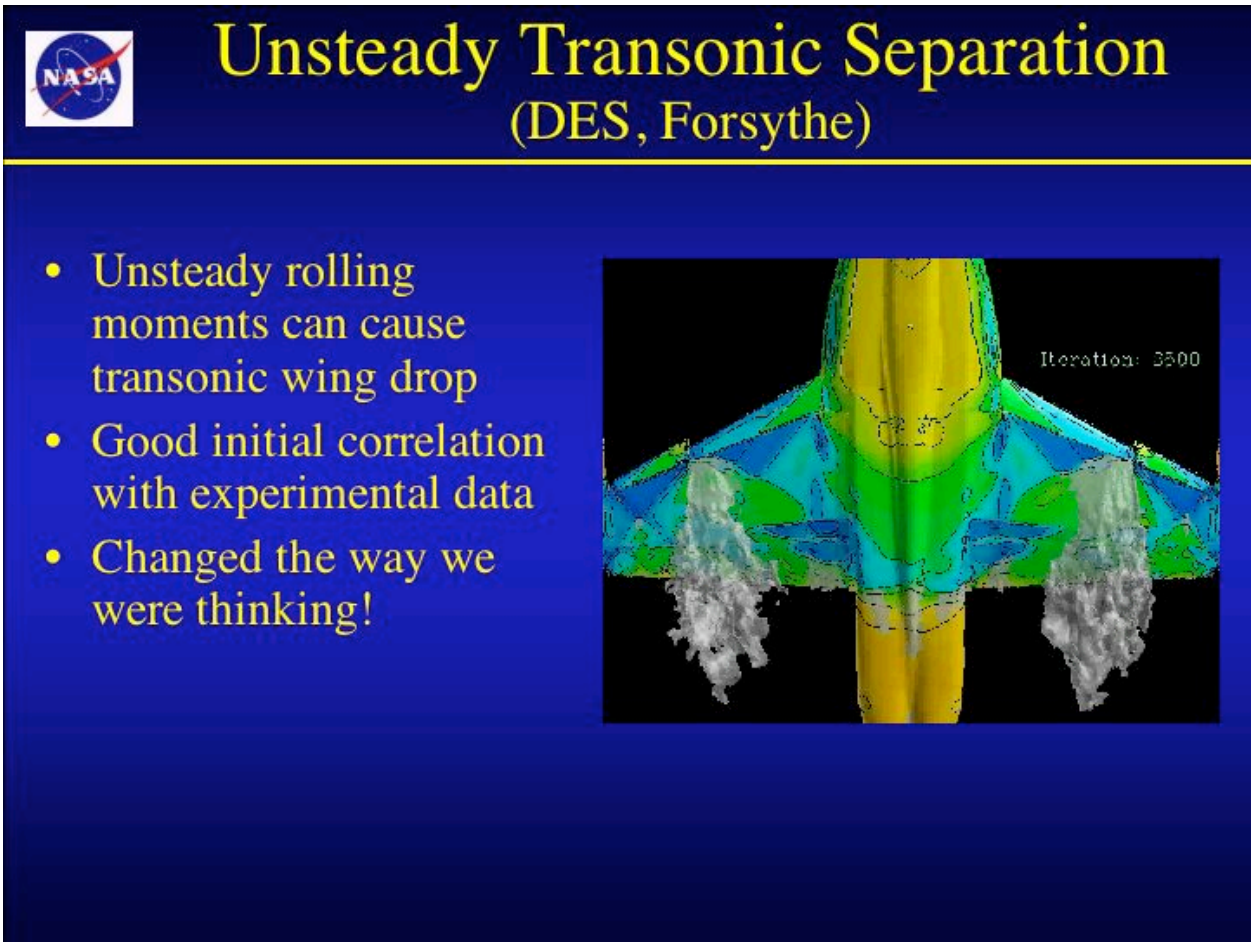


The pyramid shows the general evolution of algorithms and computer power as a function of decade. The level V is labeled RANS+ because of the addition of methodologies such as either Large Eddy Simulation (LES) or Detached Eddy Simulation (DES). The bottom line is that there are new developments in algorithms which, when combined with increasing availability of computer resources, will enable the community to address problems that previously were untenable. The challenge now facing the CFD community is to take the latest levels of technology and begin making the sort of impacts in the stability and control arena that it has already made in the performance arena.

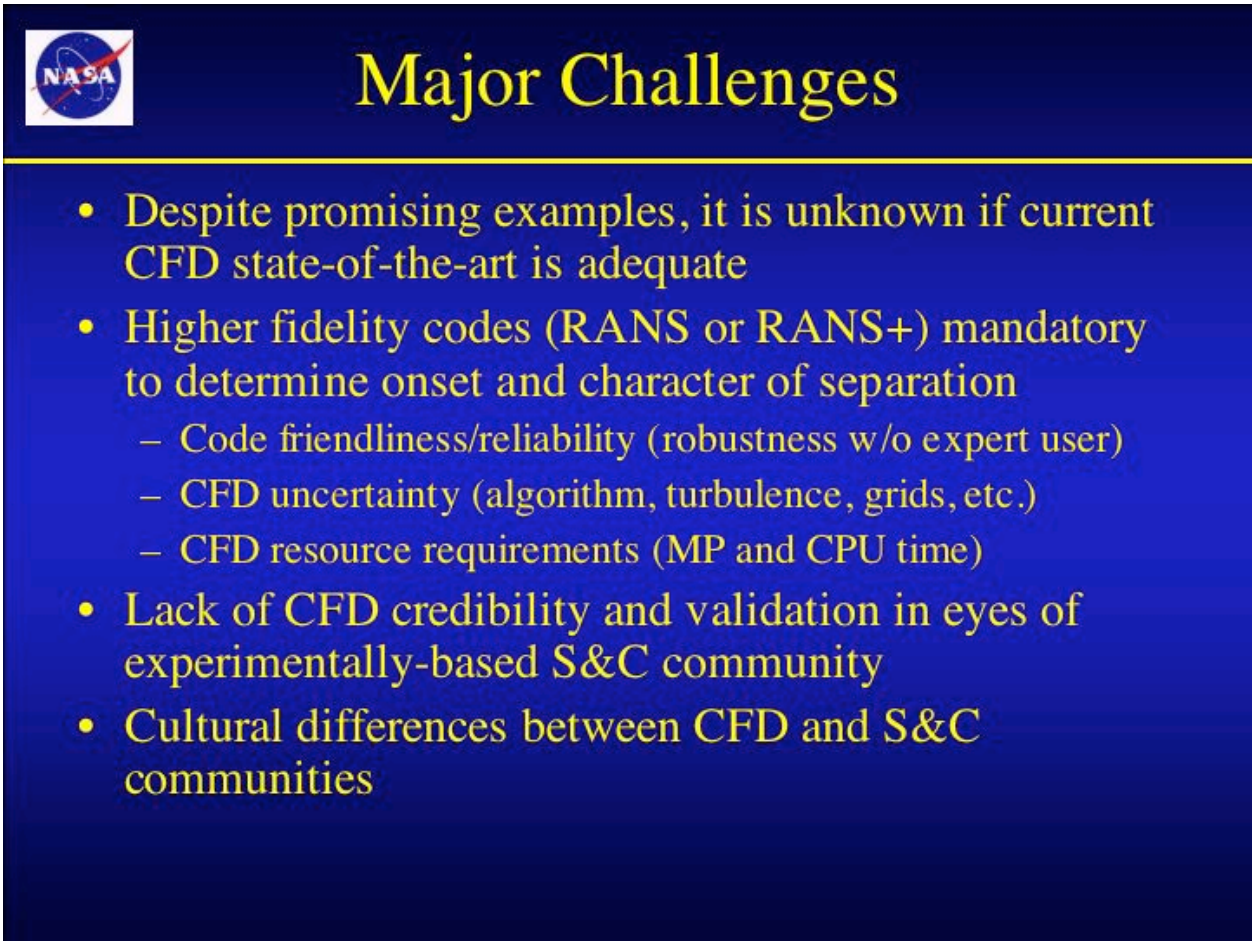


This list shows just a few of the many applications that have been addressed by the authors reporting during this Symposium. This is merely to communicate that a lot of work has already been done by a lot of organizations.

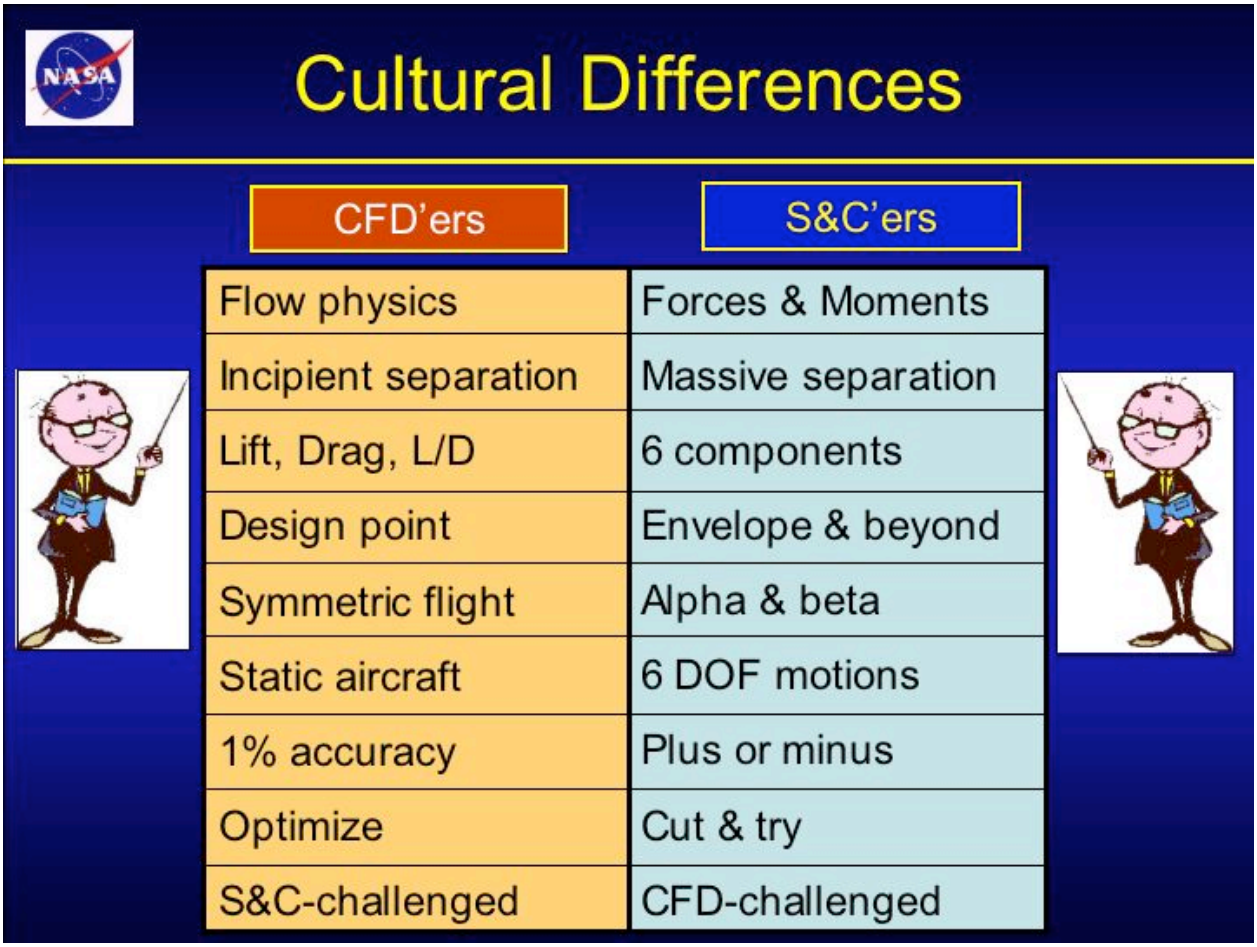
I would like to show one example with which I am familiar that comes from the Abrupt Wing Stall (AWS) program. This work was by Jim Forsythe and utilized a Detached Eddy Simulation (DES) implementation. The insight into the flow physics of this example changed the thinking of the S&C folks.



While there are examples of successes in applying CFD to S&C problems, it is still unclear within and outside of the CFD community that the current state-of-the-art is up to the task of predicting the very complicated, sometimes time dependent, flows associated with massively separated flows. What is clear, however, that it was appear that if separation is a large player in the flow field, it will be necessary to bring to the problem RANS or RANS+ levels of technology. This means that large resources will be required to address these problems. So ways will have to be found apply these codes with as much automation and robustness as possible. Of course, CFD credibility must be established in the S&C community by demonstrating that the codes can predict the answer before knowing it. Finally, while cultural differences are a challenge in bringing together the two disciplines, some of the reduced accuracy requirements associated with S&C may reduce some of the resource requirements.



This chart contrasts the differences between the two communities.



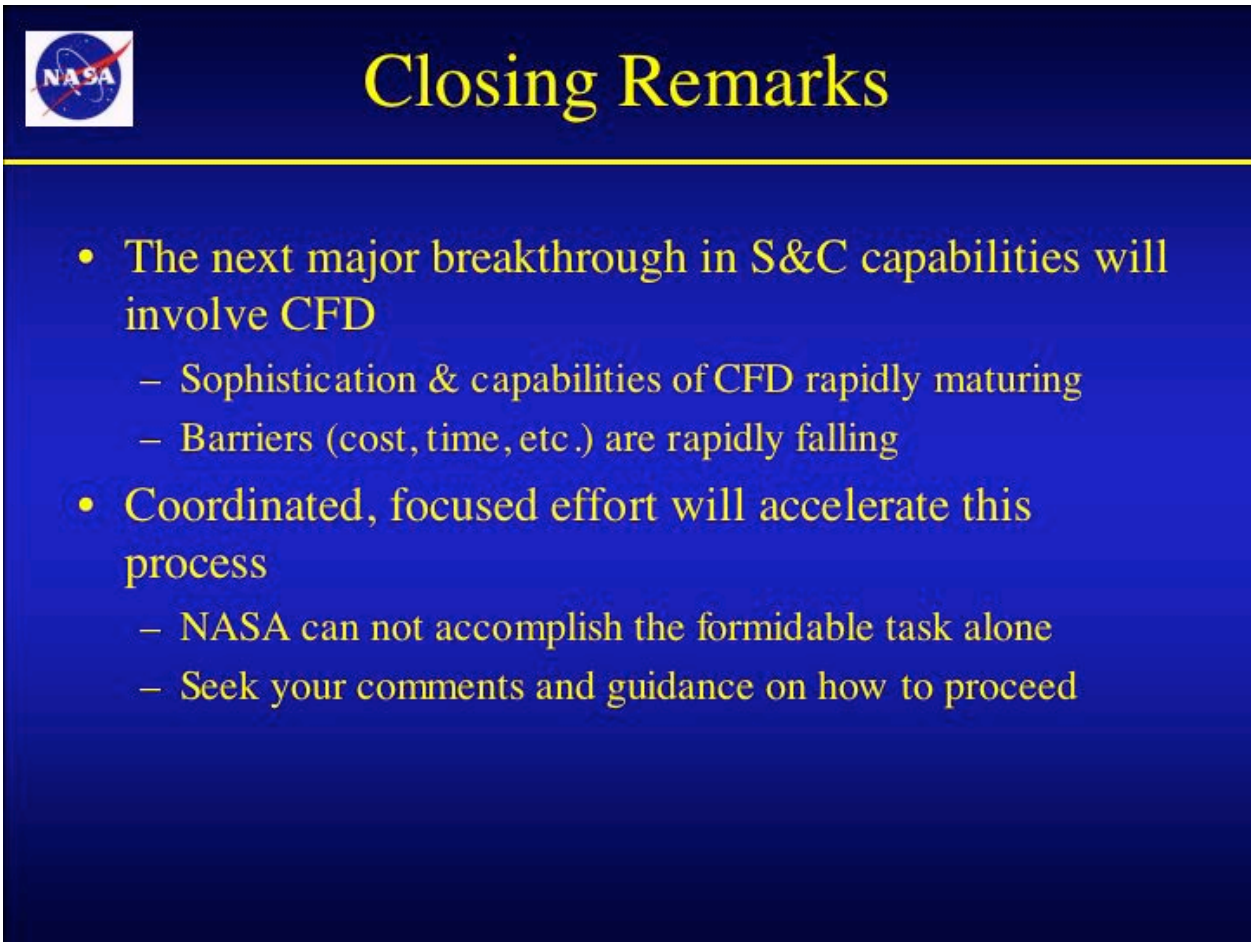
NASA has been involved with trips to different organizations to make sure we understood the level of technology and the needs of the communities.


Objectives of Symposium
• Improve communications between diverse cultures
– Inform CFD community of S&C challenges
– Inform S&C community of CFD state-of-the-art
• Share visions
– What should be done?
– How should it be done?
• Provide critique for NASA planning

•Day 1 - Tuesday, September 23, 2003			•	•
•7:15 AM	•8:15 AM	•Sign-In for Badge and Workshop-Related Materials	•	•Coffee, Juice, & Light Breakfast
•8:15 AM	•8:30 AM	•Introductory Remarks	•Darrel Tenney, NASA	**•Welcome**
•8:30 AM	•9:00 AM	•Introduction to COMSAC	•Bob Hall, NASA	**•Session 1: Overview Speakers** Session Chair: Long Yip
•9:00 AM	•9:30 AM	•Critical S&C Issues and Outlook--NASA Perspective	•Mike Fremaux, NASA	
•9:30 AM	•10:00 AM	•Emerging CFD Capabilities and Outlook--NASA Perspective	•Bob Biedron/ Paul Pao/Jim Thomas, NASA	•
•10:00 AM	•10:15 AM	•Break	•	•
•10:15 AM	•11:00 AM	•Boeing Commercial Perspective	•Doug Ball, Boeing Seattle	**•Session 2a: Perspectives & Experiences** Session Chair: Bob Hall
•11:00 AM	•11:30 AM	•Northrop-Grumman Perspective	•Dale Lorincz, Northrop Grumman	
•11:30 AM	•12:00 PM	•Boeing Military Perspective	•Dave Evans, Boeing St. Louis	
•12:00 PM	•1:00 PM	**• Lunch**	•	•
•1:00 PM	•1:30 PM	•AFRL Perspective	•Bill Blake/William Thomas, AFRL	**•Session 2b: Perspectives & Experiences** Session Chair: Bob Hall
•1:30 PM	•2:00 PM	•Raytheon Perspective	•Neal Pfeiffer, Raytheon	
•2:00 PM	•2:15 PM	•Break	•	
•2:15 PM	•2:45 PM	•NAVAIR Perspective	•Tom Lawrence, NAVAIR	
•2:45 PM	•3:15 PM	•Lockheed Martin Perspective	•Pradeep Raj, Lockheed Martin	
•3:15 PM	•3:30 PM	•Break	•	•
•3:30 PM	•4:00 PM	•Boeing TacAir S&C Issues for CFD	•Bill Hollingsworth, Boeing St. Louis	**•Session 3a: S&C Issues for CFD** Session Chair: Mike Fremaux
•4:00 PM	•4:30 PM	•NAVAIR S&C Issues for CFD	•Steve Donaldson, NAVAIR	
•4:30 PM	•5:00 PM	•Lockheed Martin (LMTAS) S&C Issues for CFD	•Russ Killingsworth, Lockheed Martin	
•	•	**•Dinner -- On Your Own**		•

Day 2 - Wednesday, September 24, 2003				
7:30 AM	8:00 AM	Arrival		Coffee, Juice, & Light Breakfast
8:00 AM	8:45 AM	Issues, Challenges, and Payoff: A Boeing CFD User's Perspective	Dave Bogue/Ron Doll/Ray Lines, Boeing Seattle	**Session 3b: Vehicle Design Issues for CFD** **Session Chair: Doug Ball**
8:45 AM	9:15 AM	Computational Simulations for S&C Conceptual & Prelim Design	Bill Mason, Va. Tech.	
9:15 AM	9:45 AM	Perspective on Separating Dynamic Stability Derivatives Using CFD	Larry Green/Angela Spence, NASA	
9:45 AM	10:00 AM	break		
10:00 AM	10:30 AM	Boeing TacAir CFD Capabilities/Issues	David Stookesberry/Frank Berrier, Boeing St. Louis	**Session 4a: CFD State-of-the-Art for S&C** **Session Chairs: Jim Thomas and Bob Biedron**
10:30 AM	11:00 AM	NASA TetrUSS Capabilities for S&C	Neal Frink/Paresh Parikh, NASA	
11:00 AM	11:30 AM	CFD Simulations for S&C -- Boeing Commercial State of the Art	N. J. Yu, Boeing Seattle	
11:30 AM	11:45 AM	break		
11:45 AM	12:15 PM	Lockheed Martin (Marietta) CFD Technology Paper	Rick Hooker, Lockheed Martin	
12:15 PM	12:45 PM	Time Dependent Calculations for S&C using OVERFLOW	Paul Pao/Pieter Buning, NASA Langley	
12:45 PM	1:45 PM	**Lunch**		
1:45 PM	2:15 PM	Application of COBALT to Abrupt Wing Stall using RANS and DES	Jim Forsythe, COBALT Solutions	**Session 4b: Application of CFD to S&C** **Session Chairs: Neal Frink and Larry Green**
2:15 PM	2:45 PM	Computational S&C Techniques for Unsteady & Aeroelastic Effects	Dave Schuster, John Edwards, NASA	
2:45 PM	3:00 PM	break		
3:00 PM	3:30 PM	Hinge Moment Predictions using CFD	Matt Grismer, AFRL	
3:30 PM	4:00 PM	CFD Simulation of Aircraft in Coning Motion	Syta Saephan, Case van Dam, UC Davis	
4:00 PM	4:15 PM	break		
4:15 PM	4:45 PM	Qualification of Large External Store Carriage for F-15 Using CFD	Jeff Batte, Eglin AFB	
4:45 PM	5:15 PM	CFD Predictions of Aircraft Fallling-Leaf Characteristics	Eric Charlton, Lockheed Martin	
6:30 PM	8:30 PM	**Group Dinner--Lecture entitled "The Challenge of Flying the World's First Aircraft"**	Colin Britcher, Old Dominion University	

Day 3 - Thursday, September 25, 2003				
7:30 AM	8:00 AM	Arrival		Coffee, Juice, & Light Breakfast
8:00 AM	8:30 AM	Uncertainty in Computational Aerodynamics	Mike Hemsch, Jim Luckring, Joe Morrison, NASA	**Session 5: Process and Validation** **Session Chair: Paul Pao**
8:30 AM	9:00 AM	A Best Practices System to Enhance CFD in S&C Applications	Mike Mendenhall, Nielsen Eng & Research	
9:00 AM	9:30 AM	Dynamic Water Tunnel Testing for Code Benchmarking	Brooke Smith, John Hodgkinson, AeroArts	
9:30 AM	9:45 AM	break		
9:45 AM	10:30 AM	NASA COMSAC "Strawman" Plan	Bob Hall, NASA	**Session 6: COMSAC: The Road Ahead** **Session Chairs: Bob Hall and Long Yip**
10:30 AM	10:45 AM	Prepared Roadmap Feedback	Pradeep Raj, Lockheed Martin	
10:45 AM	11:00 AM	Prepared Roadmap Feedback	John Clark, NAVAIR	
11:00 AM	11:15 AM	Prepared Roadmap Feedback	Doug Ball, Boeing Seattle	
11:15 AM	12:00 PM	Participant Feedback	All	
12:00 PM	12:15 PM	Summary and Wrap Up	Darrel Tenney, NASA	
12:15 PM	1:00 PM	**Lunch**		
1:00 PM	2:30 PM	Strategy for Advocacy	Darrel Tenney, NASA	**Session Chairs: Long Yip and Jim Pittman**


Closing Remarks
• The next major breakthrough in S&C capabilities will involve CFD
– Sophistication & capabilities of CFD rapidly maturing
– Barriers (cost, time, etc.) are rapidly falling
• Coordinated, focused effort will accelerate this process
– NASA can not accomplish the formidable task alone
– Seek your comments and guidance on how to proceed